AD-A045 482 NAVY UNDERWATER SOUND REFERENCE LAB ORLANDO FLA F/G 17/1

LIMITATIONS IMPOSED ON UNDERWATER ACOUSTIC MEASUREMENTS BY TEST--ETC(U)

DEC 58

UNCLASSIFIED USRL-TM-23-58 NL

1 OF 1

AD
A045482

END

DATE
FILMED

11-77

DDC

MOST Project - 4

Department of the Navy, Office of Naval Research
USN UNDERWATER SOUND REFERENCE LABORATORY
P. O. Box 8337, Orlando, Florida

WLP/hs
AR-021

(1) NW

Manuscript dated 1 December 1958
Publication date 19 Dec[redacted]58

(9) TECHNICAL MEMO[redacted] No. 23-58 (11)

(12) 6p.

From: Head, Acoustics Calibration Division
To: Head, Research and Development Department

Subj: (6) Limitations imposed on underwater acoustic measurements by test depth, test distance, transducer size, and transducer Q

Ref: (a) USRL Research Report No. 39 of 23 Aug 1956 (14) USRL-TM-23-58

Encl: (1) Figure 1. Magnitude of reflection interference in continuous-wave measurements.
(2) Figure 2. Pulse length as a function of test depth and test distance.
(3) Figure 3. Low-frequency limit for pulsed measurements.

1. PURPOSE. This memorandum presents charts that may be used to estimate the acoustic measurement capabilities of an underwater sound measurement facility. One chart shows the magnitude of acoustic interference from reflecting surfaces when continuous-wave measurements are made on an omnidirectional transducer. Two charts show the interdependence of transducer size, transducer Q, test depth, test distance, and frequency for pulsed-sound measurements.

2. BACKGROUND

a. Reference (a), titled, "Dimensions of test tanks for underwater transducer measurements," shows that the tank size varies inversely with frequency, and approximately as the square root of transducer Q. The trend to high-Q, low-frequency large transducers or large arrays of small transducers has continued until tanks can no longer be made large enough to provide satisfactory measurement conditions for the largest ones. As transducer Q (which is a measure of the sharpness of resonance or frequency selectivity) increases the pulse length required to establish the steady-state condition at or near the resonant frequency becomes impractically large. An increase in pulse length, in turn, requires an increase in test depth. A deep, open-water facility is therefore required for the calibration of high-Q, large transducers or large transducers operating at low frequencies. The Tilley Foster Mine, near

254 300

618

567/13-11

1190141-59

Gp-1

Brewster, New York, has been proposed as a site for a deep-water facility. Test depths to 100 feet and test distances to an estimated 175 feet would be available at this site.

b. The charts presented in this memorandum provide a convenient means of estimating the measurement capabilities of any test site which may be selected. The actual requirements and needs for additional sonar test facilities are not included in this memorandum.

3. DISCUSSION. The severest requirements on test conditions are those for measurement of directivity patterns of line transducers. The charts that are discussed in the following paragraphs have therefore been computed for this type of transducer. When omnidirectional transmission is used, as in the AN/SQS-4 scanning sonar without rotating directional transmission, these transducers have the characteristics of line transducers.

a. Figure 1 shows the magnitude of reflection interference that can exist in the continuous-wave type of measurement on omnidirectional transducers. To limit this type of interference to ±0.5 db, a test depth equal to nine times the test distance must be used. Reference (a) explains why test distances for directivity measurements must be ten times the line length. A line length of 1 foot requires a test distance of 10 feet and a test depth of 90 feet to limit surface reflection interference to ±0.5 db when the transducer is oriented in a horizontal position as for directivities in the XZ plane. Large transducers require impractical test depths if c-w measurements are to be made without excessive reflection interference. Pulsed sound measurements, which electronically eliminate the effect of surface reflections from the measurements, then become mandatory. Existing measurement systems require that the measured pulse contain at least a certain number of cycles, the exact number depending on several factors. The result is that a low-frequency limit exists. Below this frequency the pulse will not contain enough cycles to provide a valid measurement.

b. Figure 2 shows the pulse length as a function of test depth and test distance for a practical range of test conditions. This pulse length is the difference between the time of reception of the direct signal and the time of reception of the signal reflected from the air-water surface, or any other reflecting boundary. Transducer size has not been included in the computation of the data in Fig. 2. As transducer size increases, the pulse length decreases, but the effect is small until the transducer size and test distance approach the limiting conditions for the site. The curves in Fig. 2 are computed for

test depths as great as 200 feet, but the physical control of transducers and cables becomes increasingly difficult as test depths are increased. A minimum test depth that provides satisfactory measurements will usually be used, and it is doubtful that a test depth of more than 100 feet will be necessary or practicable.

c. Figure 3 shows the low-frequency limit of pulsed measurements for various test distances as a function of transducer length and Q. The restrictions under which the computations are valid are the same as those described in reference (a), and are briefly stated on the chart. The 35-foot line could not be measured at a 350-foot test distance in the proposed facility; satisfactory response measurements and limited directivity measurements could be made at a distance equal to five times the line length.

4. SUMMARY. Underwater sound measurements are usually limited by physical test conditions. The limitations may be estimated by the charts presented in this memorandum.

Ward L Paine

WARD L. PAINE by RJB

Copy to:
Code 200
201
215
223
210
ONR (466)
ONR (722)
ONR (400, Dr. E. Klein)
ONR (400), Dr. E. Klein)(1)(5 Jan 1959)
BUSHIPS (688A), Treitel)(1)(14 Jan 1959
ONR (466, Sapp)(1)(14 Jan 1959)

1190141-59

Fig. 1

Magnitude of Reflection Interference
Continuous-wave Measurements
(Low-frequencies and/or omnidirectional transducers)

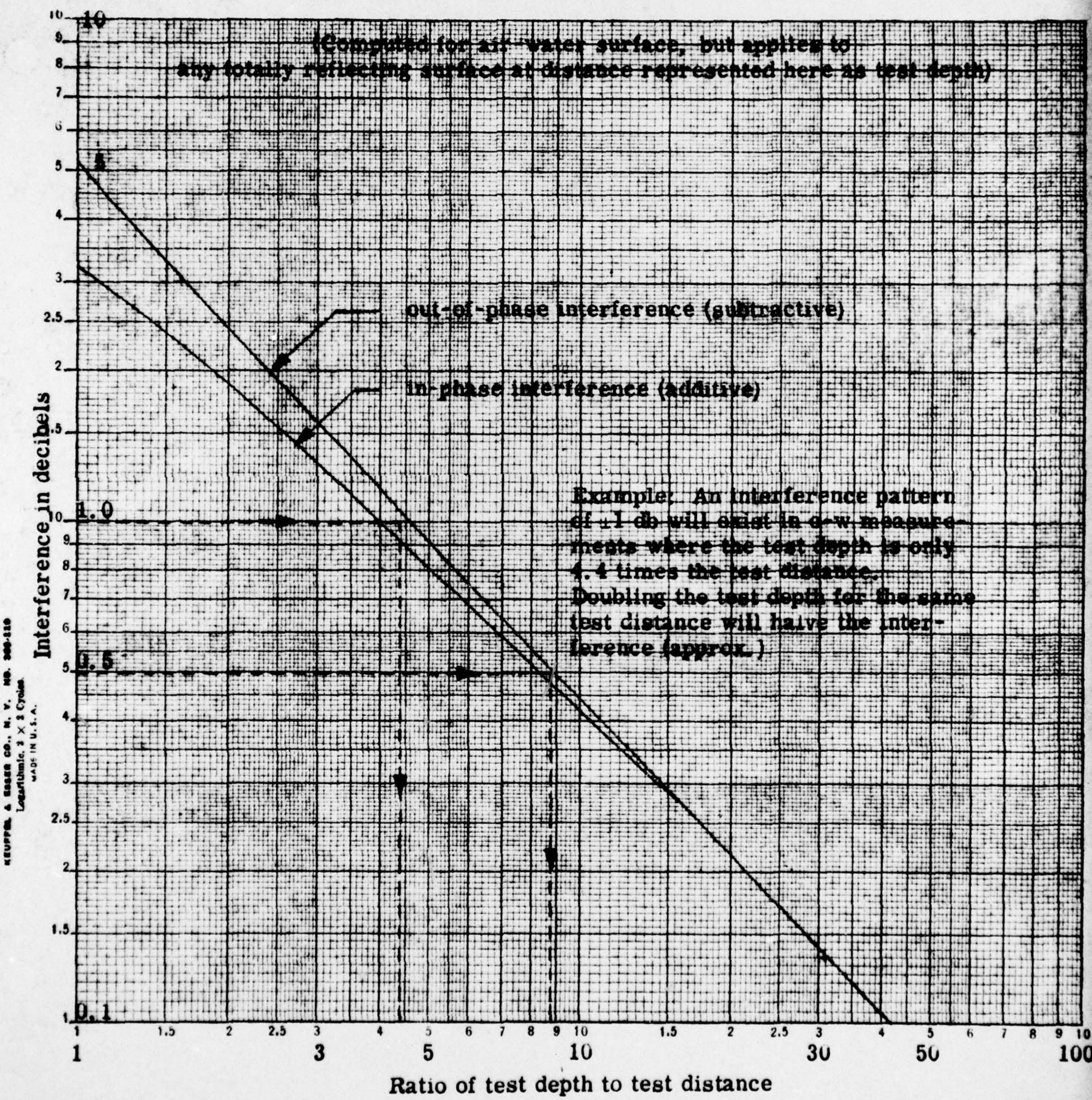

Fig. 2

Pulse Length as a Function
of Test Depth and Test Distance

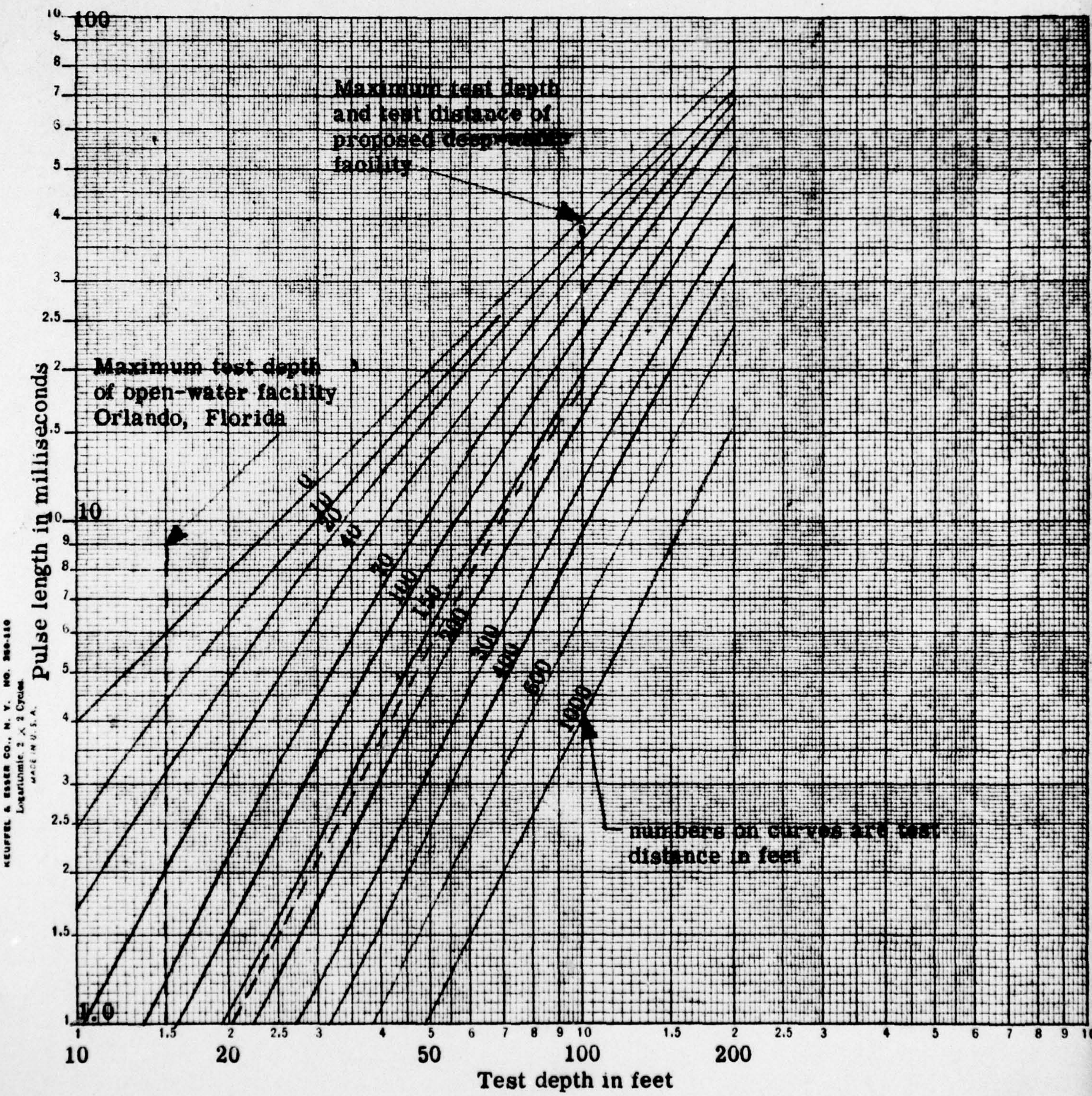

Fig. 3

Low-frequency Limit of Pulsed Measurements as a Function of Test Depth and Transducer Q